Effects of whole-lake mixing on the diet of rainbow smelt (Osmerus mordax)

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Introduction

Rainbow smelt, an invasive coldwater fish species native to the eastern coastal US, were intentionally introduced into the Laurentian Great Lakes Region in the early 1900s to serve as forage for predatory fishes (Creaser 1927). Rainbow smelt reduce populations of native fish in the systems they invade (Hrabik et al. 1998, 2001). At a local level, introduction of rainbow smelt into Sparkling Lake (Vilas County, WI) caused the extirpation of the native cisco population and in Crystal Lake, they greatly reduced the yellow perch population through competitive interactions with both adult and juvenile stages (Hrabik et al. 1998, 2001).

Crystal Lake underwent whole-lake mixing in an attempt to eradicate invasive cold-water rainbow smelt by artificially increasing water temperature. The manipulation successfully created isothermic conditions and removed all coldwater habitat required by rainbow smelt. Although the induced mortality rate was significant (90%), the mixing did not eradicate rainbow smelt from Crystal Lake (Lawson et al., 2015). The ability for this invasive species to withstand temperatures much higher than previously thought has major implications for defining suitable habitat, and predicting the future spread of rainbow smelt. Investigating the factors that may have influenced the survival of rainbow smelt in Crystal Lake is important for future eradication efforts.

Research Hypothesis

I hypothesized that a shift in diet may have helped the rainbow smelt population persist during the thermal manipulation. The mixing event removed the coldwater habitat, thereby inducing a spatial shift of rainbow smelt in an attempt to find new habitat. This movement could have changed the prey availability and prey selection, and those that were able to adapt to that change survived.

Methods

- Vertical gill nets were used to collect rainbow smelt for diet analysis
- During each year of the study, rainbow smelt diets were collected and sorted
- Diet data were used to determine diet composition for rainbow smelt throughout the project
- Pre manipulation (2010), manipulation (2012 and 2013) and post manipulation (2014) diets were compared in order to determine if the mixing had an effect on the diets of rainbow smelt
- Seasonality effects were also analyzed by comparing diets from Spring (May and June), Summer (July and August), Fall (September and October)

Results

Seasonality

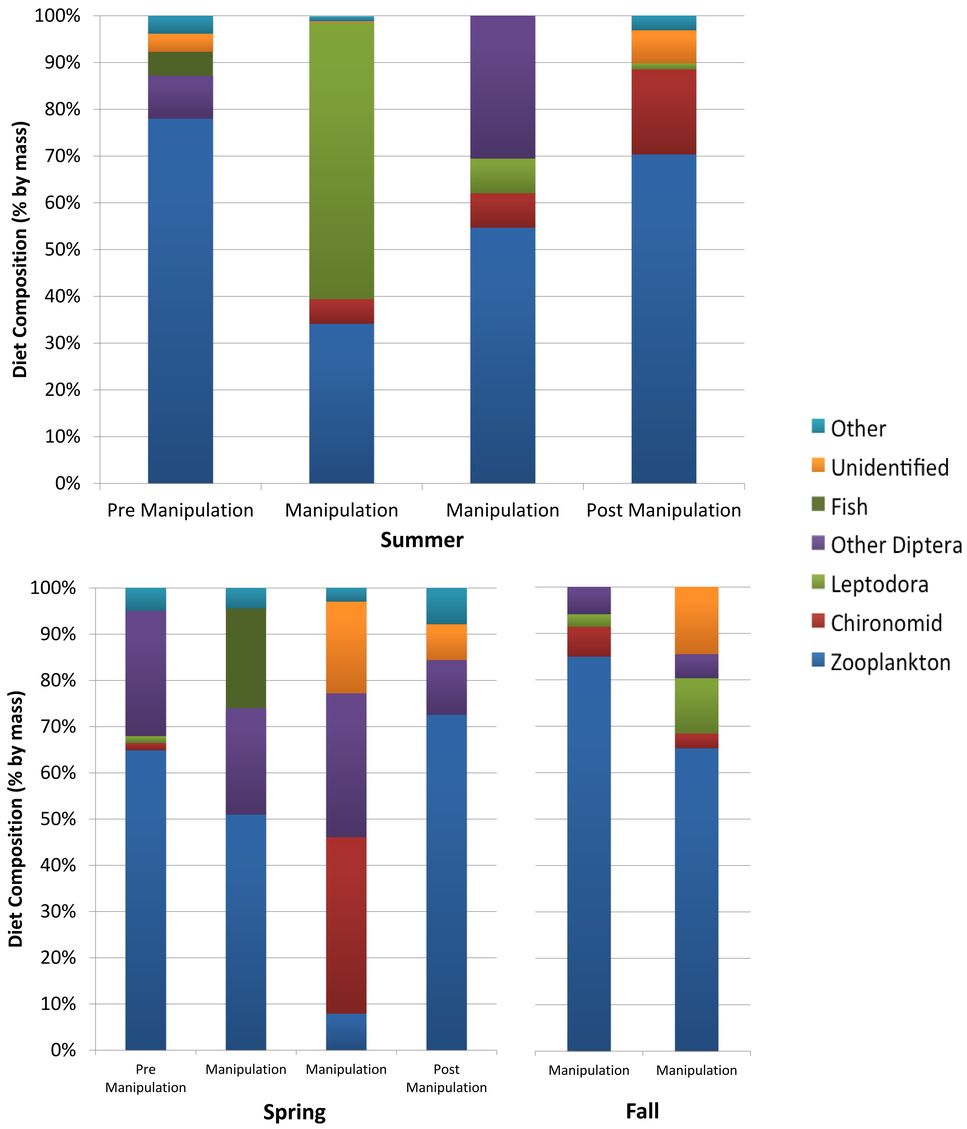

Figure 1. Diet proportions for Spring, Summer, and Fall. Proportions were found using the wet weights of each taxon.

Results Continued

Overall Trend

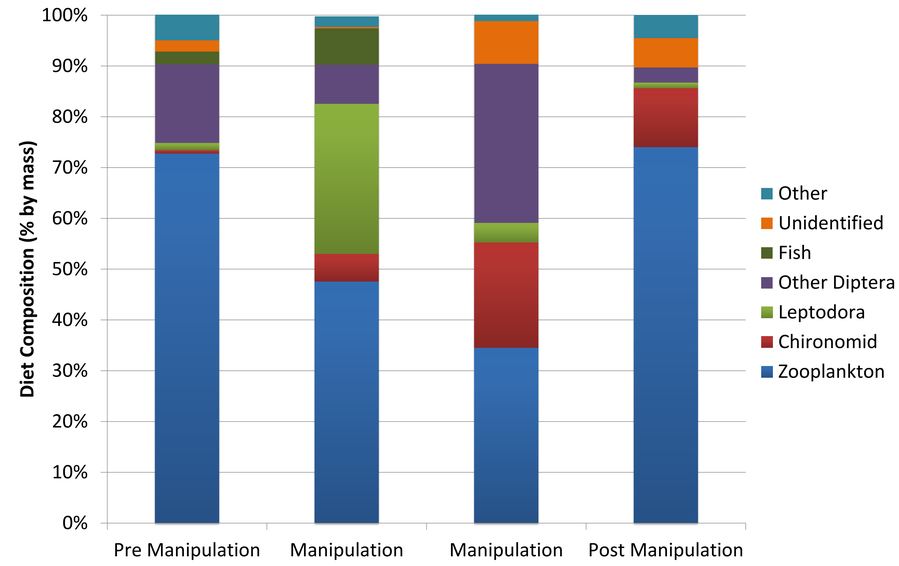

Figure 2. Average of all sampling events for each year. Spring and summer data was used.

Conclusion

- Rainbow smelt diet was effected by whole-lake mixing
- Overall, the proportion of general zooplankton decreased during mixing and returned to a high proportion after mixing
- Proportion of larger diet items increased during mixing
- Leptodora constituted a large proportion of the diet during the first year of mixing while chironomids and other diptera constituted the largest proportion of the diet in the second year of mixing
- Seasonality effects were present in the diets

Future Work

This summer I will begin processing preserved rainbow smelt and yellow perch diets in order to analyze the effect whole-lake mixing had on both species.

References

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